Docket No. PRC-143 (3351-048)

PATENT

#16 J. Douglas 1/29/04

In the United States Patent and Trademark Office

In re Application of	
Thomas S. Heath	Confirmation No. 6587
Serial No. 09/577,478	Group Art Unit: 2614
Filed: May 25, 2000	Examiner: NATNAEL, PAULOS M.
For: IMAGE ENHANCEMENT	

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Washington D.C. 20231

Attn: BOARD OF PATENT APPEALS AND INTERFERENCES

APPELLANT'S BRIEF (37 C.F.R. § 1.192)

This brief is in furtherance of the Notice of Appeal, filed in this case on November 17, 2003.

The fees required under § 1.17(f) and any required petition for extension of time for filing this brief and fees therefore, are dealt with in the accompanying TRANSMITTAL OF APPEAL BRIEF.

This brief is transmitted in triplicate.

This brief contains these items under the following headings, and in the order set forth below (37 C.F.R. § 1.192(c)):

I. Real Party in Interest.

II. Related Appeals and Interferences.

III. Status of Claims.

IV. Status of Amendments.

V. Summary of Invention.

VI. Issues.

A. First Issue

B. Second Issue

C. Third Issue

VII. Grouping of Claims.

VIII. Arguments.

A. First Issue
1. *Should the Examiner's rejection of claims 1, 2, 4, 5, 7, 11, 12, and 20-23 under 35 U.S.C. 102(e) as being unpatentable over De Bonet et al. (U.S. Patent 6,510,177, hereinafter De Bonet) be reversed?*
2. Conclusion

B. Second Issue
1. *Should the Examiner's rejection of claims 3, 6, 10, 13, and 14 under 35 U.S.C. 103(a) as being unpatentable over De Bonet be reversed?*
2. Conclusion

C. Third Issue
1. *Should the Examiner's rejection of claims 8, 9, and 15-19 under 35 U.S.C. 103(a) as being unpatentable over De Bonet in view of Szeliski et al. (U.S. Patent 6,018,349, hereinafter Szeliski) be reversed?*
2. Conclusion

IX. Appendix of Claims Involved in the Appeal.

The final page of this brief bears the attorney's signature.

I. REAL PARTY IN INTEREST

The real party in interest in this appeal is PRC Inc., a corporation of the State of Virginia, having its principal place of business in McLean, VA.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences that will directly affect, or be directly affected by, or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

A. Total Number of Claims in Application

There is a total of 23 claims in the application, which are identified as claims 1-23.

B. Status of all the claims

1. Claims cancelled:
2. Claims withdrawn from consideration but not cancelled:
3. Claims pending: claims 1-23
4. Claims allowed:
5. Claims rejected: claims 1-23

C. Claims on Appeal

Claims on appeal are claims 1-23.

IV. STATUS OF AMENDMENTS

A Notice of Appeal was filed on November 17, 2003 in response to a Final Official Action mailed on August 15, 2003. There have been no Amendments filed subsequent to the Final Official Action.

V. SUMMARY OF INVENTION

The present invention relates to an image enhancement process used in conjunction with a video mosaic process.

An embodiment according to the claimed invention includes a sequence of steps for generating an enhanced video image from a sequential series of consecutive video frames. A sequence of consecutive video frames is extracted. Page 9, lines 2-7 and page 10, lines 9-12. In Figure 9, a sequence of five consecutive video frames were extracted from a video having a rate of 30 frames per second.

Next, each of the extracted video frames is upsampled. Page 10, lines 13-16 and page 10, line 27-page 11, line 5. In one particular embodiment described in conjunction with Figure 11, an upsampling factor of 4 was found to be optimal for a given implementation, yielding consistent results without requiring greater memory and processor capability.

The upsampled video frames are then interpolated. Page 11, lines 8- 10. For example, a pixel-by-pixel average across all of the upsampled images is performed.

Next, the interpolated video frames are aligned. Page 9, lines 11- 12 and lines 18- 29. In one particular embodiment, at least one region of interest of the consecutive video frames.

Specifically, a centroid region of interest (ROI) of a frame is calculated and compared with centroid ROIs of adjacent frames. Centroid ROIs within error tolerance are selected and a full correlation of average distance from every pixel and corresponding structure is performed and a consistent difference identifies a potential match. The process is repeated for additional structures falling within the error tolerance and matches based on pixels within structures

having the most consistent differences are selected. In this manner, compensation for x-y translation, rotation, and focal length changes of the video frames is performed.

A single image is thereby created using a pixel average from each of the aligned video frames. Page 10, lines 19-24. In one particular embodiment described at page 10, lines 21-24, a series of five images are combined and averaged into a single image depicted in Figure 13.

Advantageously, the present invention enables an image enhancement process and system requiring minimal computer processing and memory capability. Minimizing computer processing and memory capability requirements is important because one particular embodiment of the present invention is performed by computer processing equipment mounted on an unmanned aerial vehicle. Page 2, lines 11-13.

These advantages are achieved by the present invention as recited in the method of independent claim 1 which provides: "A computer-implemented method of enhancing a video image, comprising: extracting a sequence of video frames; upsampling each of the video frames; interpolating the upsampled video frames; aligning the interpolated video frames; and creating a single image from the aligned video frames."

Further, these advantages are achieved by the present invention as recited in the computer architecture of independent claim 20 which provides: "A, computer architecture comprising: extracting means for extracting a sequence of video frames; upsampling means for upsampling each of the video frames; interpolating means for interpolating the upsampled video frames; aligning means for aligning the interpolated video frames; and creating means for creating a single image from the aligned video frames.

Further still, these advantages are achieved by the present invention as recited in the article of independent claim 21 which provides: "An article, comprising: at least one sequence of machine executable instructions; a medium bearing the executable instructions in machine form, wherein execution of the instructions by one or more processors causes the one or more processors to: extract a sequence of video frames; upsample each of the video frames; interpolate the upsampled video frames; align the interpolated video frames; and create a single image from the aligned video frames.

Further still, these advantages are achieved by the present invention as recited in the computer system of independent claim 22 which provides: "A computer system, comprising: a processor; and a memory coupled to said processor, the memory having stored therein sequences of instructions, which, when executed by said processor, causes said processor to perform the steps of: extract a sequence of video frames; upsample each of the video frames; interpolate the upsampled video frames; align the interpolated video frames; and create a single image from the aligned video frames.

Further still, these advantages are achieved by the present invention as recited in the computer-implemented method of independent claim 23 which provides: "A computer-implemented method of enhancing a video image, comprising: extracting a sequence of consecutive video frames; upsampling each of the extracted video frames; interpolating the upsampled video frames; aligning the interpolated video frames using at least one region of interest in the consecutive video frames; and creating a single image using a pixel average from each of the aligned video frames.

VI. ISSUES

A. First Issue

The first issue is whether the Examiner was correct in rejecting claims 1, 2, 4, 5, 7, 11, 12, and 20-23 under 35 U.S.C. 102(e) as being unpatentable over De Bonet.

B. Second Issue

The second issue is whether the Examiner was correct in rejecting claims 3, 6, 10, 13, and 14 under 35 U.S.C. 103(a) as being unpatentable over De Bonet.

C. Third Issue

The third issue is whether the Examiner was correct in rejecting claims 8, 9, and 15-19 under 35 U.S.C. 103(a) as being unpatentable over De Bonet in view of Szeliski.

VII. GROUPING OF CLAIMS

For purposes of this Appeal Brief only, the claims have been grouped as follows:

Group I. 1, 2, 4, 5, 7, 11, 12, and 20-23;

Group II. 3, 6, 10, 13, and 14; and

Group III. 8, 9, and 15-19.

For the purposes of this Brief only, claims 1, 2, 4, 5, 7, 11, 12, and 20-23, claims 3, 6, 10, 13, and 14, and claims 8, 9, and 15-19 are not argued separately and may stand or fall together. The rejected claims otherwise should not stand or fall together. The reasons why the claims are separately patentable are set forth in the Argument section of this Brief.

VIII. ARGUMENTS

A. First Issue

Should the Examiner's rejection of claims 1, 2, 4, 5, 7, 11, 12, and 20-23 under 35 U.S.C. 102(e) as being unpatentable over De Bonet et al. (U.S. Patent 6,510,177, hereinafter De Bonet) be reversed?

The Examiner was incorrect in rejecting claims 1, 2, 4, 5, 7, 11, 12, and 20-23 under 35 U.S.C. 102(e) as being unpatentable over De Bonet and the rejection should be reversed. The Examiner is incorrect for at least three reasons.

A rejection based on 35 U.S.C. §102 requires every element of the claim to be included in the reference, either directly or inherently. The Examiner has failed to identify at least three elements of claim 1 as anticipated by the De Bonet reference.

First, De Bonet operates on individual video frames from a high resolution video sequence to generate a base layer having a low resolution video stream and an enhancement layer having enhancement information (De Bonet at column 8, lines 25-42); however, nowhere in the reference is a single image created from an aligned, interpolated, upsample, extracted sequence of video frames. That is, De Bonet fails to create a single image from an extracted sequence of video frames as claimed in claim 1.

As described in De Bonet, conventional video coding includes intra picture frames (I-frames), forward predicted picture frames (P-frames), and bi-directional predicted picture frames (B-frames). De Bonet at column 2, lines 7-10. I-frames are independent pictures whereas P-frames and B-frames are encoded relative to past and past, future, or both frames, respectively. De Bonet uses a low resolution video sequence in conjunction with compressed difference information (residual) regarding I-frames, P-frames and B-frames and predictions thereof, and in one embodiment motion vectors, in order to generate a high resolution video sequence. To be clear, De Bonet attempts to recreate a sequence of video frames and not a single aligned image using a sequence of video frames.

For example, De Bonet describes the frame sequencing process as follows:

> The frame sequencing module 1040 receives the output from the I-frame decoder module 1010, the P-frame decoder module 1020 and the B-frame decoder module 1030. Namely, inputs to the frame addition module 1040 are the high-resolution I-frames (box 1175), the high-resolution P-frames (box 1178) and the high-resolution B-frames (box 1181). These frames are then appended (box 1184) to create a final output of decoded high-resolution frames (box 1187) that, depending on the amount of subscribed enhancement, are a high-fidelity representation of the original high-resolution video sequence. The final output of decoded high-resolution frames are sent (box 1187) to a viewing device (such as a high-definition television (HDTV) set). De Bonet at column 17, lines 38-50.

That is, De Bonet decodes and places in the proper sequence the high-resolution I-frames, P-frames, and B-frames for output to a viewing device. The individual P-frames, and B-frames rely on the I-frames for coding purposes, but they are not combined to create a single image. The "frames are then appended . . . to create a final output of decoded high-resolution frames . . . that, . . . are a high-fidelity representation of the original high-resolution video sequence." At no time in the De Bonet process, is a sequence of I-frames, P-frames, and B-frames or combinations thereof extracted and aligned to create a single image. Therefore, because the De Bonet reference fails to teach creating a single image from a sequence of extracted, aligned video frames, the rejection should be reversed.

Second, the Examiner asserts (page 2, paragraph c. of the Final Official Action) that step 920 of the De Bonet reference describes interpolating the upsampled video frames; however, there is no description of interpolation of upsampled video frames to be found in the reference. Specifically, the De Bonet reference solely describes step 920 in terms of the result of step 915, the upsampling of the video frames. There is no further description to be found in De Bonet regarding step 920 and without more the Examiner cannot rely on this lack of information as providing the claimed limitation.

At page 11 of the Final Official Action, the Examiner now broadly asserts that steps 920, 945, and 950 are types of interpolation. Based on the foregoing discussion and without

more, step 920 cannot be relied on as a type of interpolation. Step 945 of De Bonet calculates a residual frame that is the difference between the predicted frame and the actual frame taken from the high-resolution video sequence. Thus, there is no estimation of a value between two known values: the difference between the two frames (predicted and actual) is determined.

Further, even assuming for the sake of argument that interpolation was performed in this step, there is no interpolation of upsampled video frames because the difference calculated is between the actual video frame and one of the I-frame, P-frame, and B-frame. Continuing with this assumption, the up-sampled I-frames, P-frames, and B-frames are not interpolated as asserted by the Examiner. Rather, the actual video frame (not up-sampled) would be interpolated with the up-sampled video frame contrary to the claim 1 limitation claiming interpolating the upsampled video frames.

With reference to the Examiner's argument regarding step 950 and reference to column 14, lines 7-10 of De Bonet, modification of residual values in the residual frames is not interpolation of the up-sampled video frames. The Examiner erroneously jumps to the conclusion that interpolation is being performed by relying on the statement that "the modification is based on an assessment of the visual importance of each residual value." De Bonet at column 14, lines 9-11. Modification does not necessarily mean interpolation and the De Bonet reference does not provide further information. Without more information, the Examiner has not shown the claimed interpolation of the upsampled video frames in the reference.

Further, step 950 modifies the residual frames received from step 945 and not the up-sampled I-frames output from step 915. The up-sampled I-frame output of step 915 is used to generate the predicted I-frames of step 920 which are then used in the calculation of the residual frame output of step 945; however, the up-sampled I-frame output of step 915 is not an input to step 950. There is no interpolating the up-sampled video frames as claimed by claim 1 and the rejection should be reversed.

Third, the Examiner asserts that the step of aligning the interpolated video frames is inherent because the alignment is a necessary step or process without which the image wouldn't

be displayed properly. Final Official Action at page 3, paragraph d. The Examiner is incorrect because the De Bonet reference does not create a single image, rather a sequence of multiple video frames are decompressed and sequenced as described above, there is no need for aligning the video frames. Contrary to the Examiner's assertion that De Bonet "suggests that the video signal is output as one video signal from the encoder to the satellite transmitter, and then received by the receiver to be displayed as one signal on a display" (Final Official Action at page 12, paragraph b.), the claim language recites "creating a single image" and not one video signal. In operation, the De Bonet system employs a frame sequencing module 1040 to receive "the high-resolution I-frames (box 1175), the high-resolution P-frames (box 1178) and the high-resolution B-frames (box 1181)" which "are then appended (box 1184) to create a final output of decoded high-resolution frames (box 1187) that . . . are a high-fidelity representation of the original high-resolution video sequence. The final output of decoded high-resolution frames are sent (box 1187) to a viewing device." De Bonet at column 17, lines 42-50. The present invention requires alignment of the interpolated video frames because a single image is created based on an extracted sequence of video frames. For least this reason, the rejection of claim 1 should be reversed.

Claims 2, 4, 5, 7, 11, and 12 depend, either directly or indirectly, from claim 1, incorporate further important limitations, and are patentably distinguishable from the applied reference for at least the reasons presented for claim 1 above, and the rejection of claims 2, 4, 5, 7, 11, and 12 should be reversed.

Claims 20-23 are patentably distinguishable from the applied reference for reasons similar to those presented with respect to claim 1 above, and the rejection of claims 20-23 should be reversed.

Conclusion

For the extensive reasons shown above, Appellant respectfully requests the rejection be reversed.

B. Second Issue

Should the Examiner's rejection of claims 3, 6, 10, 13, and 14 under 35 U.S.C. 103(a) as being unpatentable over De Bonet be reversed?

The Examiner was incorrect in rejecting claims 3, 6, 10, 13, and 14 under 35 U.S.C. 103(a) as being unpatentable over De Bonet and the rejection should be reversed.

The Examiner asserted that the up-sample step of a factor of four claimed in claim 3 would be an obvious matter of design choice and that any factor would perform equally well with the disclosed sampling method. "The mere fact that a worker in the art could rearrange the parts of the reference device to meet the terms of the claims on appeal is not by itself sufficient to support a finding of obviousness. The prior art must provide a motivation or reason for the worker in the art, without the benefit of appellant's specification, to make the necessary changes in the reference device." Ex parte Chicago Rawhide Mfg. Co., 223 U.S.P.Q. 351, 353 (Bd. Pat. App. & Inter. 1984). The Examiner has failed to identify the required motivation or reason for the worker in the art to make the necessary changes.

The Examiner's attention was directed to the present specification, specifically to page 11, lines 1-5, wherein the specification describes the factor of 4 as found by the inventor to be optimal and yielding the most consistent results. Further, specific benefits of using a factor of four are described, as well as reasons for not using a higher factor. Specifically:

> As depicted in Figures 10 and 11, the images are upsampled by factor 4. Other upsampling factors could be used, but the factor of 4 appears to be optimal, yielding the most consistent results. Less than 4 could be used, but the idea is to create the highest resolution possible. Using a factor greater than 4 will result in diminishing returns, in that the amount of memory and processor capacity required will not necessarily produce a sufficiently higher quality image. Specification at page 10, line 28 through page 11, line 5.

For at least this reason, it would not have been an obvious matter of design choice to modify the De Bonet reference to use an up-sampling factor of four as asserted by the Examiner. Because the De Bonet reference fails to include the specific limitation and does not render the limitation obvious, the rejection of claim 3 should be reversed.

Claims 6 and 13 depend from claim 1, incorporate further important limitations, and are patentable over the De Bonet reference for at least the reasons presented with respect to claim 1 above, and the rejection of claims 6 and 13 should be reversed.

Claim 10 depends from claim 1, incorporates further important limitations, and is patentable over the De Bonet reference for at least the reasons presented with respect to claim 1 above, and the rejection of claim 10 should be withdrawn. Further, as described above with respect to claim 1, the Examiner has not identified where in the De Bonet reference the asserted interpolation is performed. For at least this reason, the rejection of claim 10 should be reversed.

Claim 14 depends from claim 1, incorporates further important limitations, and is patentable over the De Bonet reference for at least the reasons presented with respect to claim 1 above, and the rejection of claim 14 should be withdrawn. Further, as described above with respect to claim 1, the Examiner is incorrect with respect to the De Bonet reference inherently correlating the video images because De Bonet does not align the video frames and create a single image from the aligned video frames. No alignment of video frames is required, taught, or suggested by the De Bonet reference. For at least this reason, the rejection of claim 14 should be reversed.

Conclusion

For the extensive reasons shown above, Appellant respectfully requests the rejection be reversed.

C. Third Issue

Should the Examiner's rejection of claims 8, 9, and 15-19 under 35 U.S.C. 103(a) as being unpatentable over De Bonet in view of Szeliski be reversed?

The Examiner was incorrect in rejecting claims 8, 9, and 15-19 under 35 U.S.C. 103(a) as being unpatentable over De Bonet in view of Szeliski and the rejection should be reversed.

The Examiner has failed to identify any motivation or suggestion in either reference teaching, suggesting, or describing the asserted combination of references. The Examiner appears to have improperly applied hindsight reasoning based on the present invention to make the asserted combination.

Further, the references operate in a different manner and produce a different output. That is, the De Bonet reference is directed to video frames of a video stream, while the Szeliski reference is directed to a combination of still images to construct a mosaic.

A statement that combinations of the prior art to meet the claimed invention would have been well within the ordinary skill of the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references. See MPEP 2143.01 quoting Ex parte Levengood, 28 USPQ2d 1300 (Bd. Pat. App. & Inter. 1993). The Office Action merely stated that the references can be combined, which Appellants contend to the contrary, and does not state any desirability for making the combination. In other words, the Office Action failed to supply any objective reasons to combine the applied references.

The Examiner asserts that in order to further enhance the quality of video data, a person of skill in the art at the time would have been motivated to provide pixel averaging as described by Szeliski in the De Bonet system without identifying any such teaching, suggestion, or motivation in either reference. Similar to the above discussion related to claim 1 and the aligning the video frames step, De Bonet does not require alignment of video frames. Szeliski requires alignment of video frames because the Szeliski system combines multiple images into a single mosaic. As stated by the Examiner, "Szeliski et al. discloses a patch-based alignment method and apparatus for construction of image mosaics." There is no such combination of images or frames in De Bonet. The fact that Szeliski may teach blending pixel values using a weighted average does not identify the necessary teaching, suggestion, or motivation in either reference to combine the references.

In accordance with MPEP §2143.01 and Al-Site Corp. v. VSI Int'l Inc., 174 F.3d 1308, 50 USPQ2d 1161 (Fed. Cir. 1999), the Examiner was requested to identify a teaching, suggestion, or motivation in either reference providing a motivation or suggestion to one of ordinary skill in the art to make the argued combination. The Examiner has not identified any teaching in De Bonet or Szeliski motivating or suggesting the asserted combination to a person of ordinary skill in the art because there is no teaching to be found. For at least this reason, the rejection should be reversed.

"When an obviousness determination is based on multiple prior art references, there must be a showing of some 'teaching, suggestion, or reason' to combine the references." Winner International Royalty Corp. v. Wang, 53 USPQ2d 1580, 1586 (Fed. Cir. 2000). The Examiner has failed to make such a showing supporting the applied combination of references and therefore the applied combination of references is improper. The Examiner is in error for any of the above reasons and has not made out a prima facie case of obviousness, and the rejection of claim 8 should be reversed.

With respect to claim 9, the Examiner asserts that compensation for platform movement and rotation zoom would have to be made to prevent images from being distorted and artifacts introduced in the composite image; however, as previously pointed out to the Examiner and as described above, there is no composite image created in the De Bonet reference. Further, as described above with respect claim 8, the Examiner has failed identify any motivation or suggestion in either reference teaching, suggesting, or describing the asserted combination. For either of these reasons, the rejection of claim 9 should be reversed.

Claim 16 is patentable over the applied combination of references for reasons similar to those advanced above with respect to claim 9 and the rejection of claim 16 should be reversed.

Claim 17 depends indirectly from claim 1 and is patentable over the applied combination of references for at least the reasons advanced above with respect to claims 1 and 8, and the rejection of claim 17 should be reversed.

Claim 18 depends from claim 17, includes further important limitations neither anticipated nor rendered obvious by the applied references, and is patentable over the applied

combination of references for at least the reasons advanced above with respect to claims 11 and 17, and the rejection of claim 18 should be reversed.

Claim 19 depends from claim 18, includes further important limitations neither anticipated nor rendered obvious by the applied references, and is patentable over the applied combination of references for at least the reasons advanced above with respect to claims 12 and 18, and the rejection of claim 19 should be reversed.

Conclusion

For the extensive reasons shown above, Appellant respectfully requests the rejection be reversed.

Each of the Examiner's rejections has been traversed. Appellant respectfully submits that all claims on appeal are considered patentable over the applied art of record. Accordingly, reversal of the Examiner's Final Rejection is believed appropriate and courteously solicited.

If for any reason this Appeal Brief is found to be incomplete, or if at any time it appears that a telephone conference with counsel would help advance prosecution, please telephone the undersigned, Appellant's attorney of record.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 07-1337 and please credit any excess fees to such deposit account.

Respectfully submitted,
LOWE HAUPTMAN GILMAN & BERNER, LLP

Randy A. Noranbrock
Registration No. 42,940

1700 Diagonal Road, Suite 310
Alexandria, Virginia 22314
(703) 684-1111
(703) 518-5499 Facsimile:
Date: January 20, 2004

IX. APPENDIX OF CLAIMS INVOLVED IN THE APPEAL

1. A computer-implemented method of enhancing a video image, comprising:
extracting a sequence of video frames;
upsampling each of the video frames;
interpolating the upsampled video frames;
aligning the interpolated video frames; and
creating a single image from the aligned video frames.

2. The method of claim 1, wherein the sequence of video frames are low resolution images.

3. The method of claim 1, wherein said upsample step is by a factor of 4.

4. The method of claim 1, wherein said align step comprises aligning the video images in an x direction and a y direction in a center portion of interest in each video frame.

5. The method of claim 1, comprising extracting the sequence of video frames at 30 frames/sec.

6. The method of claim 1, wherein the sequence of video frames includes 5 video frames.

7. The method of claim 1, comprising correlating the upsampled video images.

8. The method of claim 7, comprising averaging a pixel intensity from each of the upsampled video frames.

9. The method of claim 1, comprising compensating for platform movement and rotation zoom.

10. The method of claim 1, comprising aligning each the extracted sequence of video frames before said upsample step.

11. The method of claim 1, comprising identifying commonality from one individual frame to the next and overlapping the individual frames and displaying an image representing a continuous area.

12. The method of claim 11, comprising extracting the sequence of video frames at 30 frames/sec.

13. The method of claim 12, wherein the sequence of video frames includes 5 video frames.

14. The method of claim 13, comprising correlating the upsampled video images.

15. The method of claim 14, comprising averaging a pixel intensity from each of the upsampled video frames.

16. The method of claim 15, comprising compensating for platform movement and rotation zoom.

17. The method of claim 16, comprising aligning each the extracted sequence of video frames before said upsample step.

18. The method of claim 17, comprising identifying commonality from one individual frame to the next and overlapping the individual frames and displaying an image representing a continuous area.

19. The method of claim 18, comprising extracting the sequence of video frames at 30 frames/sec.

20. A computer architecture, comprising:

extracting means for extracting a sequence of video frames;

upsampling means for upsampling each of the video frames;

interpolating means for interpolating the upsampled video frames;

aligning means for aligning the interpolated video frames;

and creating means for creating a single image from the aligned video frames.

21. An article, comprising:

at least one sequence of machine executable instructions;

a medium bearing the executable instructions in machine form, wherein execution of the instructions by one or more processors causes the one or more processors to:

extract a sequence of video frames;

upsample each of the video frames;

interpolate the upsampled video frames;

align the interpolated video frames; and

create a single image from the aligned video frames.

22. A computer system, comprising:

a processor;

and a memory coupled to said processor, the memory having stored therein sequences of instructions, which, when executed by said processor, causes said processor to perform the steps of:

extract a sequence of video frames;

upsample each of the video frames;

interpolate the upsampled video frames;

align the interpolated video frames; and

create a single image from the aligned video frames.

23. A computer-implemented method of enhancing a video image, comprising:

extracting a sequence of consecutive video frames;

upsampling each of the extracted video frames;

interpolating the upsampled video frames;

aligning the interpolated video frames using at least one region of interest in the consecutive video frames; and

creating a single image using a pixel average from each of the aligned video frames.